



August 10, 2021

BY ELECTRONIC FILING

Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street, N.E.
Washington, DC 20554

Re: *Mitigation of Orbital Debris in the New Space Age, IB Docket No. 18-313*

Dear Ms. Dortch:

This is to inform you that on August 6, 2021, representatives from Space Exploration Holdings, LLC ("SpaceX") had a conference call with Commissioner Simington and his staff. A full list of attendees is provided in Attachment A. In the meeting, SpaceX discussed the presentation attached in Attachment B.

Sincerely,

/s/ David Goldman

David Goldman
Director of Satellite Policy

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Attachments

ATTACHMENT A

Commissioner Simington's Office

Commissioner Simington

Carolyn Roddy

Erin Boone

Adam Cassady

Michael Sweeney

Isabella Russo-Tiesi

SpaceX

Jeffrey Tooley

Alex Petrov

Erik Babcock

Kevin Wu

David Goldman



ATTACHMENT B



August 2021

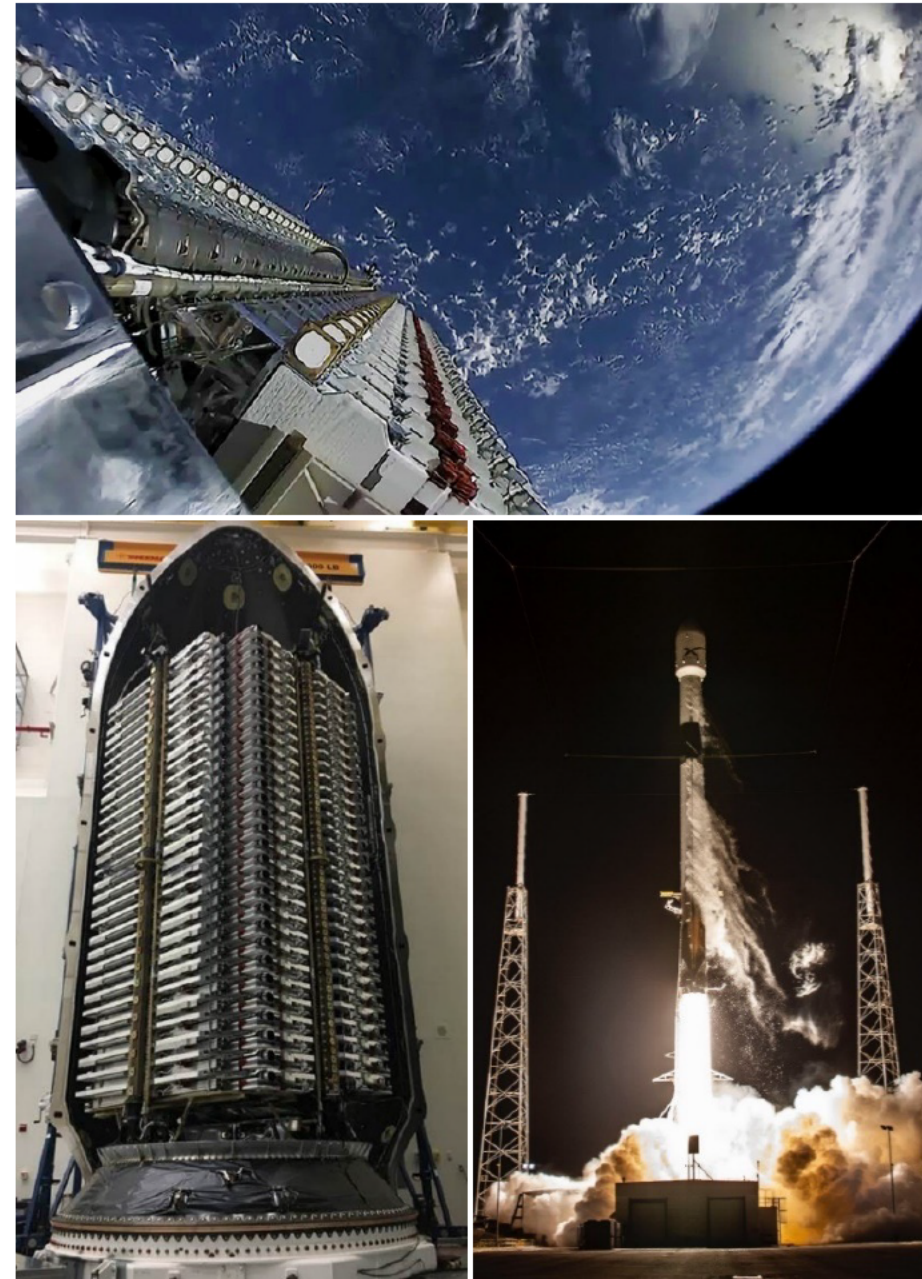
SPACEX STARLINK

ORBITAL SPACE SAFETY



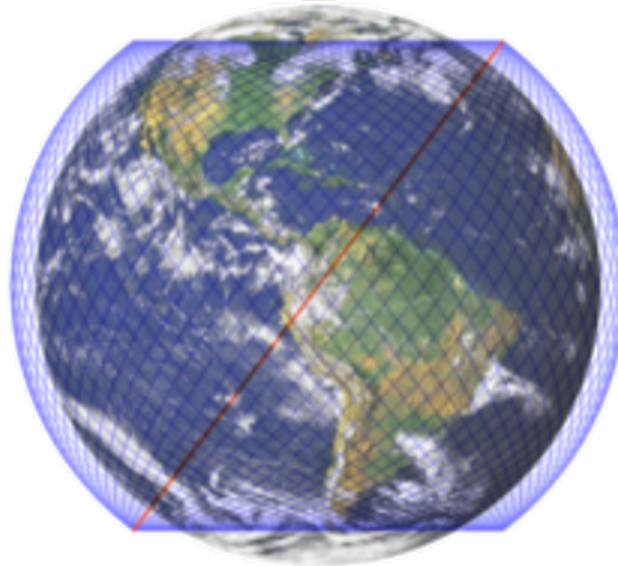
Starlink Space Safety Considerations

- **Collision Avoidance**
 - Starlink-on-Starlink
 - Starlink-on-Debris
 - Starlink-on-Other Operator
 - Starlink-on-Human Spaceflight
- **Satellite Reliability**
 - Avoiding dead-on-arrival satellites
 - Avoiding satellites becoming non-maneuverable
- **End-of-Life Decommissioning**
 - Avoiding leaving satellites in space
 - Avoiding risk to humans on re-entry
- **The Role of Altitude in Constellation Safety**
- **Regulatory Considerations**



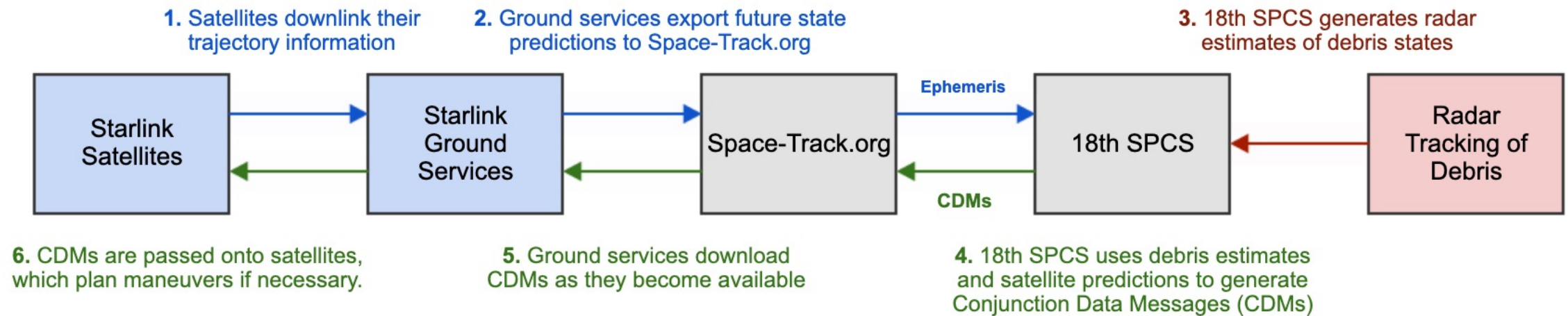
Collision Avoidance: Starlink-on-Starlink

- Starlink constellation orbits are “passively” deconflicted
 - Each satellite gets assigned a station-keeping slot.
 - Every slot is passively deconflicted (via orbit design) against all other slots in the constellation.
 - While satellites remain in their station-keeping slots (via station-keeping burns) they are guaranteed to avoid conflicts with other Starlinks that are also in their slots.
 - The “Active” collision avoidance system is the **second** line of defense.
 - The vast majority of Starlink collision avoidance maneuvers are against orbital debris, or 3rd party satellites; not other Starlinks



Collision Avoidance: Starlink-on-Debris

- Space is populated with existing debris, tracked by the 18th Space Control Squadron.
- Starlink utilizes an automated collision avoidance system, ingesting data from the 18th
 - Satellites can autonomously evaluate risk and plan avoidance maneuvers, without human input
 - Humans are still present in an oversight role, as an added measure of safety



Collision Avoidance: Starlink-on-Other Operator

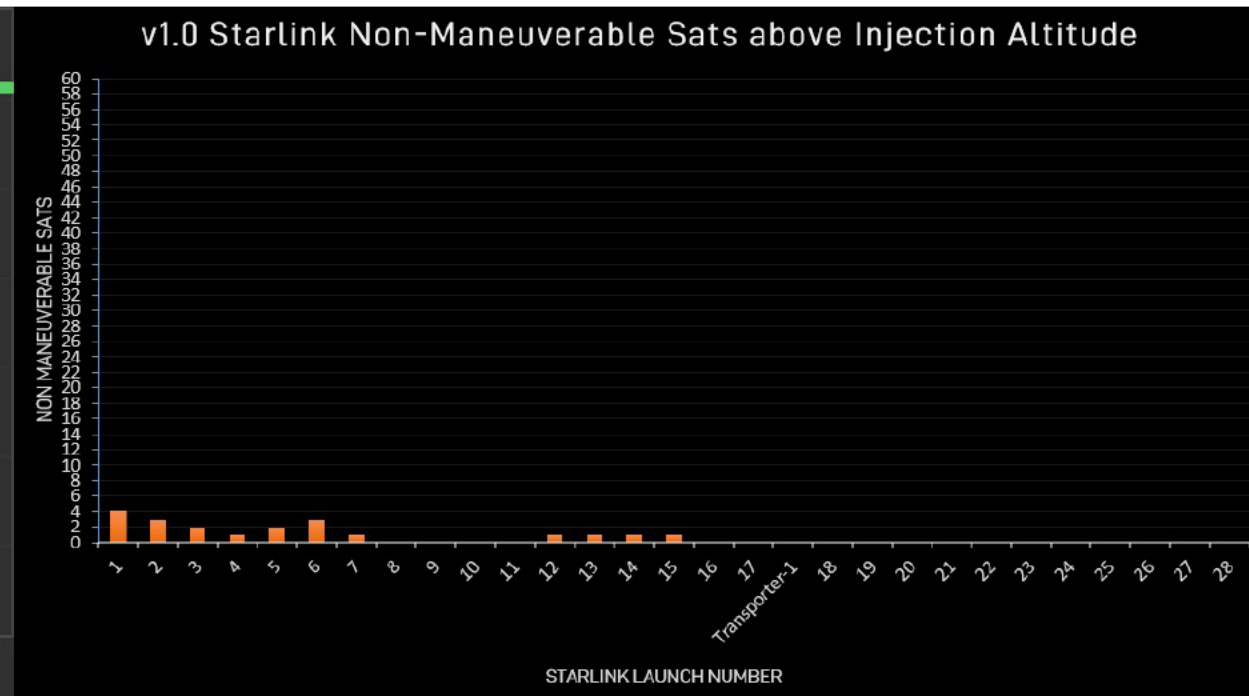
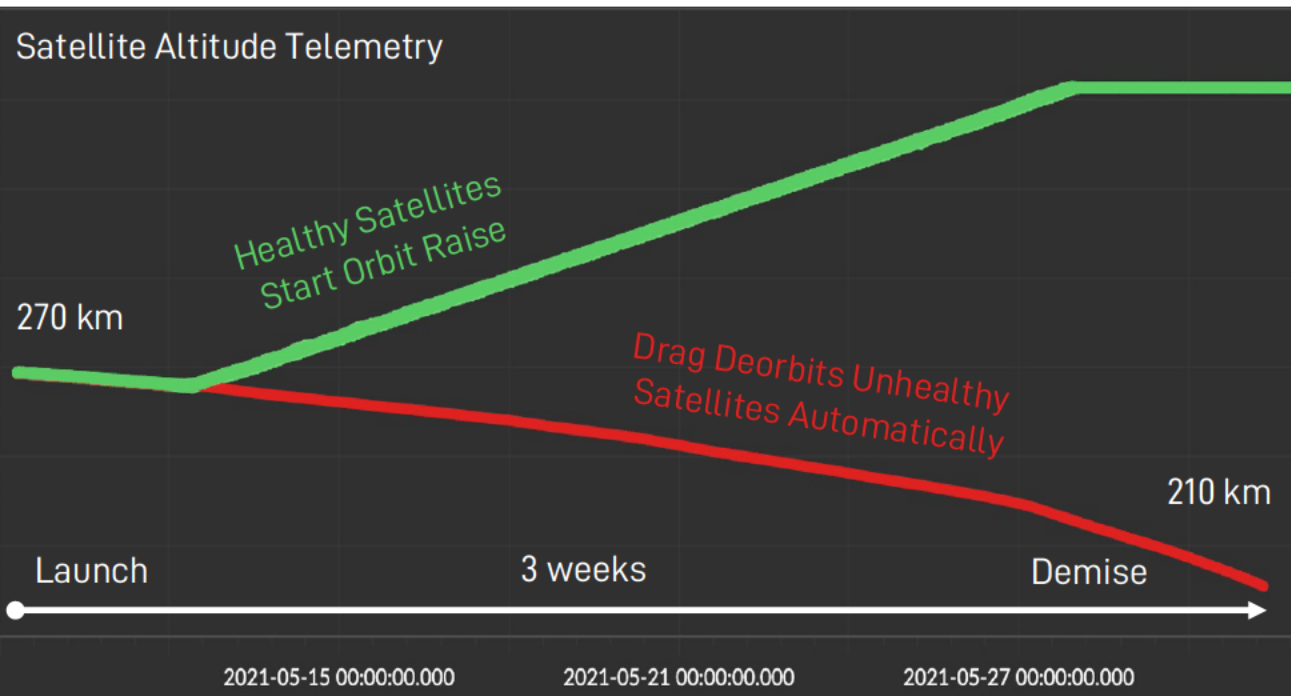
- Starlink is committed to being a responsible member of the space community.
- Though Starlink collision avoidance is automated, there are always humans on-call to coordinate and promptly respond to any external operator inquiries.
- When a maneuverable Starlink satellite sees a conjunction with another satellite:
 - Without intervention, Starlink satellites will assume maneuver responsibility
 - If another operator prefers to maneuver instead, Starlink satellites can be commanded to remain ballistic for the span of the conjunction event
- Due to the lack of industry-standard automated maneuver-responsibility arbitration methods, Starlink satellites currently default to taking maneuver responsibility for conjunction events with other operators
 - Starlink maintains more detailed coordination dialogues with operators who represent a large fraction of Starlink conjunctions.

Collision Avoidance: Starlink-on-Human Spaceflight

- Starlink trajectories are deconflicted with the ISS on a “Macro” scale, designed to avoid Starlinks showing up in ISS screenings
 - Prevents introducing unnecessary hazards to ISS and human spaceflight operations
 - Avoiding ISS by a wide margin makes it so that no additional NASA operational actions or dedicated monitoring is necessary
- The Starlink team works closely with NASA to coordinate if necessary for cargo and crew visiting vehicles

Starlink Satellite Reliability

- Starlink satellites are not inserted directly into their operational orbit.
 - Typically deployed to a low altitude (~270km), only raising to station (~550km) after passing health checkouts
 - Any satellites which do not pass initial health checks are quickly disposed of by atmospheric drag
- Starlink reliability has been continuously improving since the first v1.0 launch, via:
 - Rapid hardware iteration, quickly rolling out improvements for any identified deficiencies
 - Rapid fleet-wide software updates; with ability to use software workarounds to alleviate certain hardware issues
- Non-maneuverable but alive satellites still retain partial ability to mitigate risk in conjunctions



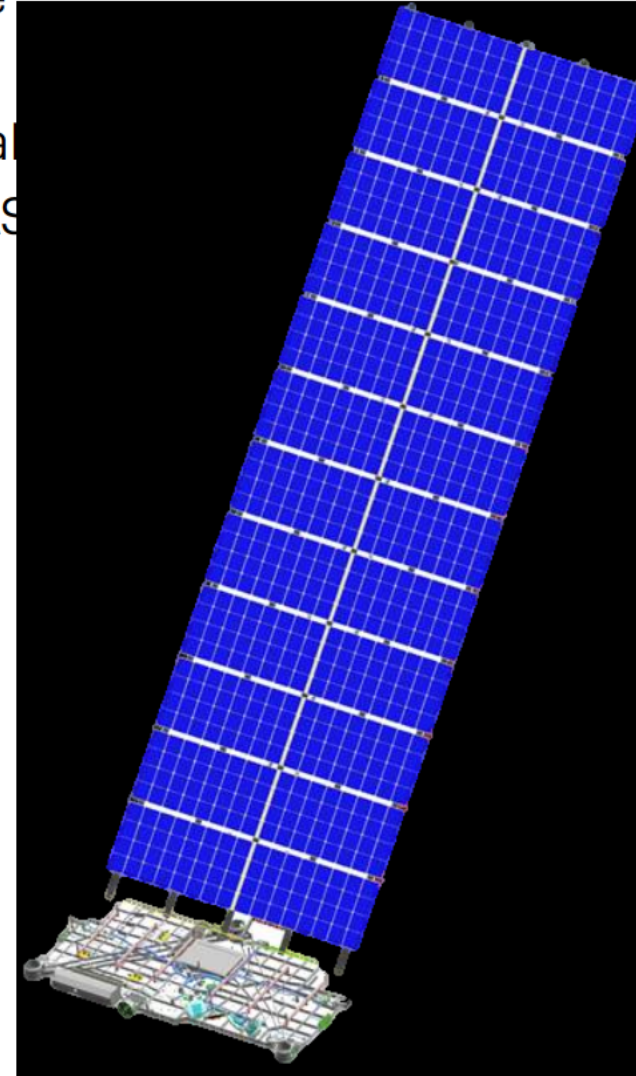
End-of-Life Decommissioning

- Starlink satellites are designed to propulsively deorbit
 - Capable satellites will propulsively deorbit at end-of-life
 - Satellites experiencing issues can be sent down early
- v1.0 Starlink satellites are designed to be fully demised
 - Pose zero Risk of Human Casualty, analyzed by DAS

Passive Decay Collision Risk for Non-Maneuverable Satellites (per DAS)

Altitude (km)	Collision Risk During Decay	Decay Time
540 km	0.000033	2.8 years
560 km	0.000094	3.3 years
570 km	0.000071	3.9 years
1150 km	0.039	100++ years

Averaged across start of each year from 2019-2029 to account for variable solar cycles



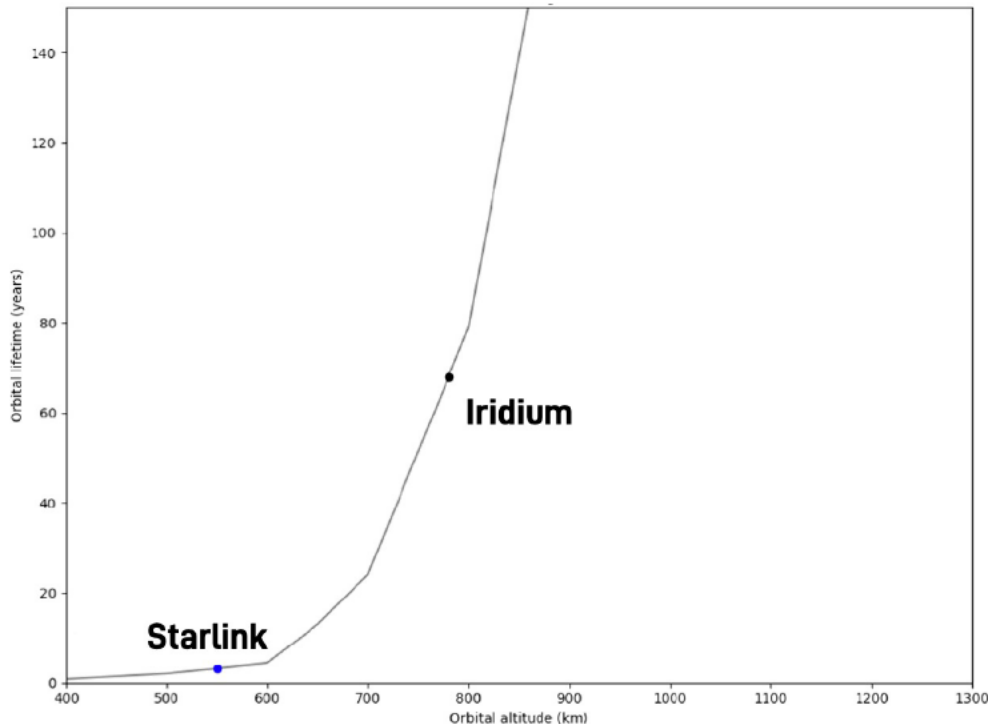
Area-to-Mass ratio facilitates
faster drag decay for the small
collection of satellites that may be
unable to propulsively deorbit

Satellites are flat and lack
components which can
survive during re-entry

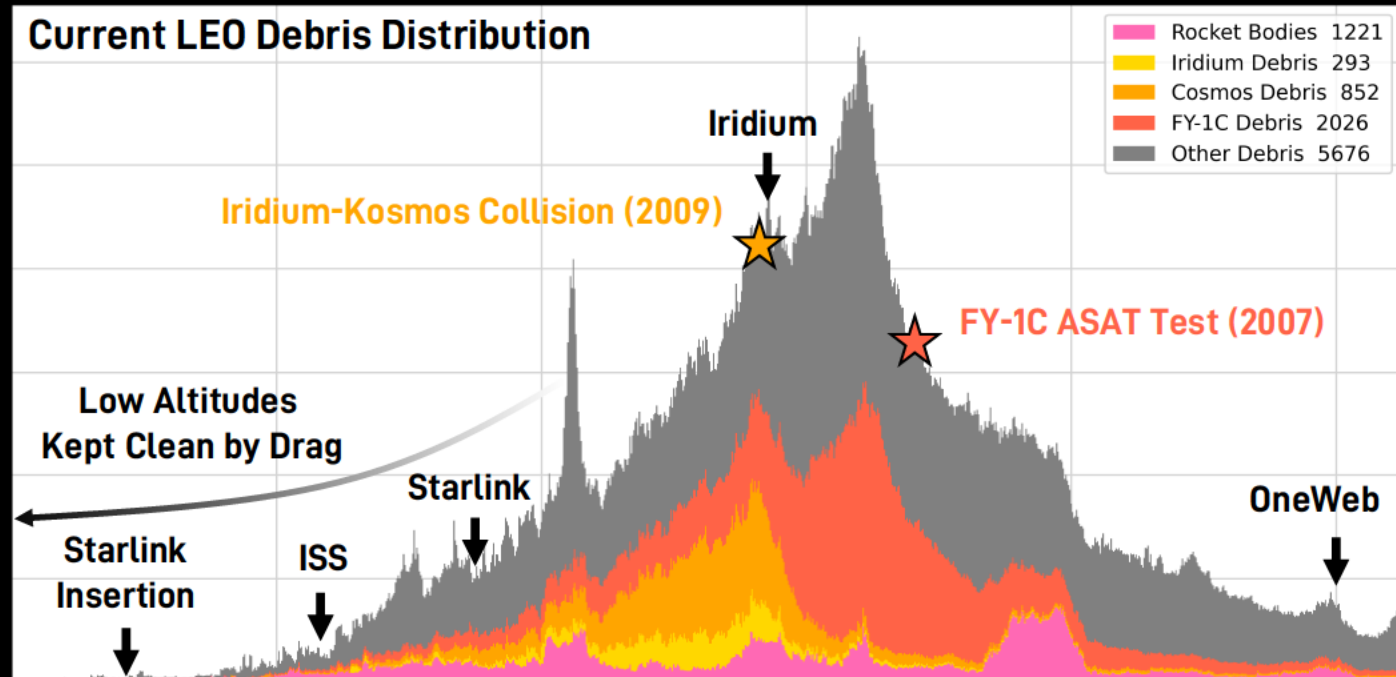
The Role of Altitude in Constellation Safety

- Atmospheric drag decays exponentially as altitude increases
- Low altitudes (< 600 km) are “self-cleaning” – debris decays passively over a few years
 - A non-maneuverable Starlink satellite at 550km will typically deorbit within 5 years
- Effect of drag is very small at high altitudes - debris can remain in orbit for tens to hundreds of years
 - While dead satellites can theoretically be retrieved – any debris from collisions will remain for a long time

Passive Decay Time vs. Altitude (40 kg/m²)



Current LEO Debris Distribution



Regulatory Considerations

- Operators licensed internationally are not held to same debris mitigation standards as US filed systems.
 - This can lead to a disincentive for licensing through the US.
 - Undermines strong US rules – unsafe systems can “forum shop” for a more lenient place to file.
- Key challenge is how to regulate NGSO systems objectively and safely, without being overly restrictive, hindering innovation or limiting benefits of new space based capabilities. Considerations:
 - Must account for total mass (energy) and altitude (persistence) when assessing impact of collision
 - Highly developed conjunction strategies and operations are key to managing a constellation safely
 - Satellite reliability is critical to passive decay and post mission disposal
 - Satellite count by itself is not a meaningful metric
 - No reporting requirement for failed sats and ephemeris outside of SpaceX